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Problem-based learning as a multimedia design framework in teacher education

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Abstract

Interactive multimedia (IMM) and problem-based learning (PBL) are both significant trends in contemporary educational practice but they have not been widely applied together in teacher education. An IMM package based on PBL principles is being developed to assist teachers in learning to integrate technology into their teaching. It incorporates examples of the work and reflections of experienced teachers in a framework designed to engage users with authentic problems of professional practice. Preliminary evaluation of a prototype suggests that the strengths of IMM and PBL can be combined to good effect.

Problem-based learning as a multimedia design framework in teacher education

In response to the advent of personal computers in schools, the energies of teacher educators have generated successive waves of activity. They have variously sought to assist teacher education students towards computer literacy, to encourage the integration of computer software across the curriculum and to model the use of computers in their own teaching. Most of the early efforts in these areas could reasonably assume that students had limited experience of computers but this is no longer the case.

Students entering teacher education programs from secondary school now are likely to have been exposed to computers from their earliest years and to possess at least basic knowledge and skills. Many of them expect that technology will play a significant role in their educational experience (Albion, 1996). The next wave formed by the combined energies of teacher educators must be directed towards using these technologies to improve the quality of processes and outcomes in teacher education.

One component of this wave of creative effort must focus on incorporating quality teaching processes into a variety of media not dependent upon face to face teaching. Rather, such efforts should be designed to support the increasing interest in flexible, open and distance learning options being offered by higher education institutions. These options are especially relevant to the needs of those who by reason of distance or work commitments cannot readily attend classes and who seek access to opportunities for professional development or to new careers. Moreover, the same flexible options are relevant to the needs of students in traditional face to face courses who seek a richer range of learning experiences amidst demands placed on their time by family and other commitments. In the face of these developments students today are developing attitudes and skills relevant for a lifetime of learning.

One educational approach which has gathered momentum because of its relevance to these trends is Problem Based Learning (PBL). PBL has been adopted for the preparation of professionals in fields as diverse as medicine, engineering, law and business. Its characteristic focus on the presentation of authentic problems as the starting point for learning has resulted in a measurable increase in the motivation of students and in their ability to integrate knowledge from foundation disciplines in pursuit of a solution to practical professional problems.

This paper describes the design and preliminary evaluation of an interactive multimedia package based upon PBL principles and intended to develop the capacity of beginning teachers to solve problems inherent in integrating technology into their teaching. The package is an outgrowth of successive developments within a teacher education course that has incorporated a problem based learning approach to solving a variety of problems contained within realistic teaching scenarios.

Learning to teach with technology

Although computers are now widely available in schools, their educational impact has been limited. Only a small proportion of teachers actively integrate information technology in their teaching (Plomp & Pelgrum, 1993) and it has been estimated that as few as 3% could be regarded as exemplary in their use of computers for teaching (Becker, 1994). According to US and Australian studies of experienced computer-using teachers (Hadley & Sheingold, 1993; Sherwood, 1993), the principal barriers to computer use include limited access to computer hardware and software, perceived inadequacies in training, lack of support and lack of time for preparation.

Contrary to expectations, newly graduating teachers may be no better prepared for technology integration than their more experienced colleagues. Fewer than 25% of graduates

from US institutions considered themselves adequately to thoroughly prepared for using computers in instruction (Handler, 1993) and Western Australian beginning teachers rated themselves lower than experienced colleagues on computer usage (Oliver, 1993). Studies of computer use by preservice teachers during practicum (Albion, 1996; Downes, 1993) suggest that, despite positive dispositions towards computer use, they lack confidence in their ability to integrate technology in their teaching.

If teachers are to be successful at integrating technology it will not be sufficient for them to develop the capacity for confident personal use of computers. They will also require an understanding of how to adapt curriculum and pedagogy to incorporate technology. It is this dimension of technology use that presents the greater challenge to teacher education programs.

Research has found that support from like-minded peers is a significant factor in the development of teachers who succeed in integrating technology (Becker, 1994) and that teachers value opportunities to share the experience of colleagues who have succeeded with computers (Sherwood, 1993). This evidence suggests that examples of effective practice with technologies may assist teachers to acquire the insights that will enable them to adapt their own practice to incorporate the use of technology.

Learning and reasoning from examples are important components in the development of expertise (Chi & Bassok, 1989; Dreyfus & Dreyfus, 1986) especially in ill-structured domains (Spiro, Feltovich, Jacobson, & Coulson, 1991a) where problems are ill-defined and there may be no single agreed solution. Teaching exhibits these characteristics and there is interest in examples or cases as a means of expressing teachers' accumulated knowledge and as an integral component of teacher education (Carter & Unklesbay, 1989).

The importance of teacher educators providing examples of technology use through modeling has been noted elsewhere (Parker, 1997; Zachariades & Roberts, 1995). However, even in the event that such modeling were practised widely and well, it would still be beneficial for students to encounter examples of good practice in contexts similar to their future employment. Field experience is the logical venue for such examples but it is difficult to ensure that students are exposed to uniformly good examples. Approaches which ensure that all student teachers have access to suitable exemplars are required.

Problem Based Learning

Problem-based learning (PBL) developed in response to concerns that the focus of conventional university education on the academic disciplines might not be the most effective preparation for future professionals. Since originating in North American medical schools in the 1960s PBL has spread to many countries and different fields of professional education (Boud & Feletti, 1991).

According to Boud (1985), a PBL encounter typically begins with presentation of an authentic problem of practice to students without any prior preparation. Following initial analysis of the problem which is usually undertaken in a small group, areas of learning are identified for individual study and the knowledge and skills acquired in this way are applied back to the problem. The final reflective phase provides opportunity to summarize what has been learned and to integrate it with each students prior knowledge. Among the advantages claimed are increased motivation and better integration of knowledge across disciplines.

A variation on the typical PBL sequence has been described by Gibson and Gibson (1995) in the context of teacher education. Students were initially presented with a one page printed scenario describing a situation typical of the beginning years of teaching and required to analyze

the scenario and develop three alternative plans for action with projections of the likely consequences of each. During face to face tutorial sessions following the generation of individual written responses, students were involved in a variety of group processes designed to increase the benefit of interaction with colleagues in the context of seeking solutions to the problem.

In focussing on the solution of authentic problems as a context for acquiring a range of relevant knowledge, PBL methodology accords well with the theories of expertise proposed by Dreyfus and Dreyfus (1986). They argued that the performance of experts tends to be characterized by non-propositional knowledge and proposed that skill acquisition at and beyond the third of the five stages they identified in their description of the development of expertise may be best served by construction of sequences of situational case studies. Such cases ought to include rich contextual information and should engage students in discussion and interpretation based on experience of previous cases.

Compared to other professions, PBL appears to have had relatively little impact on teacher education. Chappell and Hager (1995) reported that although professional courses around the world, including nursing, design, engineering, optometry, architecture, law and business were using problem-based approaches they were aware of no instance where this was occurring in teacher education. Although limited implementations of problem-based learning in specific components of teacher education courses have been reported (Gibson & Gibson, 1995; Ritchie, Norris, & Chestnutt, 1995), as yet there appear to be no published instances of wider application of PBL to an entire teacher education course.

It is by no means clear why PBL has been less widely adopted in teacher education than in other professional courses. One possible explanation is that case-based approaches to teacher education (Shulman, 1992) are meeting the needs of teacher education programs for relating

professional preparation to the experience of practitioners. However, problem-based learning should not be confused with case methods (Bridges, 1992) and deserves to be considered for the unique contribution that it might make to the professional education of teachers.

PBL and Multimedia

Computer-based systems to support PBL have been described for several specific areas of study. In one example from teacher education, a Problem Solving Assistant was used to support students through access to research resources and by use of an eight-step problem-solving heuristic (Ritchie, Norris, & Chestnutt, 1995). An architectural course has engaged students in problem-based learning using sophisticated computer graphics systems (Hart, 1996) and a biotechnology program has supported collaborative PBL using network technologies including web pages (Mackenzie, Kitto, Griffiths, Bauer, & Pesek, 1997). The Collaborative Learning Laboratory (Koschmann, Kelson, Feltovich, & Barrows, 1996) comprising seven linked computer workstations has been designed according to carefully articulated principles to support PBL meetings in medical education. It provides for data to be exchanged among participants as well as for access to a variety of resources.

Despite the interest in computer support of PBL, there appear to be few published studies of multimedia use in PBL contexts. Hoffman and Ritchie (1997) found no published articles describing how multimedia might address problems with the delivery of PBL courses. Taking as their base the PBL characteristics identified by Bridges (1992), they identified ways in which interactive multimedia might be used to support PBL. The key benefits anticipated were:

fidelity use of multiple modalities to overcome limitations in written or oral problem descriptions;

representational richness increased richness of interconnection of ideas through multiple exposure as described by cognitive flexibility theory (Spiro, Feltovich, Jacobson, & Coulson, 1991b);

time and timeliness random access to components in multimedia systems supports students need for just-in-time information;

individualization multimedia systems can be constructed to present variations of basic problems according to the entering characteristics of students;

assessment computer systems offer opportunities for monitoring student progress and simulated settings may permit testing of performance that would not be readily or safely accessible in reality;

efficiency use of algorithms and templates for preparation of multimedia representations of problems (Ritchie, Norris, & Chestnutt, 1995) may save time for instructors and students; and

increased power of agency multimedia systems can enable access to problem contexts which are not available in the classroom and at the same time provide guidance at critical junctures.

Ronteltap and Eurelings (1997) have described the functional design of POLARIS, a proposed electronic learning environment for PBL. Their model is based upon explicit instructional design principles and incorporates both individual and collaborative learning environments. Students would work in the individual environment accessing resources and preparing materials for presentation to the group through the collaborative environment. Since it is envisaged that the collaborative environment would support electronic interaction, it may not be necessary for groups to meet physically and the system support the needs of distance or flexible learning.

Each of these computer based systems offers to facilitate and enrich the experience of PBL and at least two (Mackenzie et al., 1997; Ronteltap & Eurelings, 1997) introduce technologies which support distance or flexible learning approaches. However, all are designed primarily to support existing collaborative approaches to PBL and do not propose the use of multimedia to facilitate flexible individual access to PBL experiences.

In contrast to PBL, interactive multimedia is most often viewed as a technology which promotes opportunities for individual rather than group learning and it may be this aspect which has mitigated against its adoption for PBL. However, many professional practitioners including teachers find that much of their work is performed in circumstances where they are required to act alone. Multimedia produced with a PBL approach may offer opportunities for students to engage in individual work both in traditional courses and in flexible or distance mode.

It is against this background that the project described in this paper was developed in response to the needs of beginning teachers to experience the challenges associated with integrating technology into their teaching and to obtain access to exemplars of appropriate practice.

Project background

Over the past several years the final unit in curriculum planning taken by University of Southern Queensland students preparing for employment as primary school teachers has used a problem-based learning approach to heighten students appreciation of the realities of practice. Early iterations of the unit introduced print based scenarios in which students are presented with a teaching problem that might be encountered during the first years of teaching. Students are required to clarify the problem and to prepare three possible solutions for the problem, giving due regard to professional and ethical issues and to relevant educational theory. The individually

prepared written responses are presented in tutorial sessions and processed in the group to maximize the benefit of collegial interaction.

During 1994 interactive television was introduced to afford students the opportunity to observe and interact with teachers on remote sites (Gibson & Gibson, 1995). By linking the interactive sessions with the problem-based scenarios, students were able to gain a deeper appreciation of the realities of teachers work. Students especially valued the opportunity to observe the work of teachers and to hear teachers comments on the teaching process.

Designing PBL Multimedia

Interactive television sessions present significant logistical challenges and despite their popularity and evident success with students it was doubtful that funding would permit their use on a routine basis. Videotapes of the sessions were made for use in subsequent years, but video does not offer the same opportunity for engagement through interaction as was available to the original group of students.

The multimedia CD-ROM project arose from a desire to present students with video and other materials in a framework that would support engagement through direct interaction rather than passive viewing. Prior success with PBL approaches in the context of the unit led to speculation about the possibilities of merging multimedia and PBL to maximize the benefits of both.

The design of interactive multimedia based on PBL principles presents particular challenges in that, while the nature of interactive multimedia encourages individual use, PBL most commonly involves groups of learners interacting. In bringing these two threads together it was necessary to preserve the essential characteristics which lend each its peculiar efficacy.

Development of the design model and the way in which the different modes of operation of interactive multimedia and PBL were reconciled has been described in detail elsewhere (Albion & Gibson, 1998; Gibson & Albion, 1997). Briefly, there is evidence (De Grave, Boshuizen, & Schmidt, 1996) that a significant role of the group interaction in PBL is to effect conceptual change through cognitive dissonance and the design intent in the multimedia product is to use examples prepared by a panel of experienced teachers to challenge the initial ideas of the user.

Users of the CD-ROM are invited to play the role of a teacher in a succession of temporary postings each of which presents a problem related to planning for the integration of technology into teaching. Each problem begins with an activation task in which the user prepares a brief statement relevant to an employment selection criterion related to the problem. A series of planning tasks follows and these are designed to elaborate upon existing professional knowledge and consolidate practice and understanding within a new technology based learning context. The problem concludes with a final task designed to encourage reflection and integration of what has been learned. As each task is completed users have opportunity to compare their response with the responses prepared by a panel of experienced teachers.

A teacher's desk equipped with, among other things, a laptop computer, notebook and resource materials is used to provide a consistent interface throughout the problems. This central navigational device allows access to both the storyline within each problem and to a collection of audio, video and textual resources designed to assist the user in developing solutions to the problems encountered. In addition to the responses from the teacher panelists, users have access to a variety of documents based on those found in schools, demographic data about classes, web sites and video interviews with technology using teachers.

Evaluation

The original plan for formative evaluation of the CD-ROM anticipated that a group of final year teacher education students (n = 30) would have up to four hours in which to interact with a complete working version of the first of the four problems envisaged for the package. The software was to include the problem scenario and associated tasks together with a variety of relevant resources and model responses from a panel of teachers.

Delays in the development schedule and the other commitments of students beyond the originally scheduled evaluation dates resulted in a smaller group of students (n = 14) having no more than 2 hours to interact with a very early prototype of the software. Nevertheless it was decided to proceed with the evaluation in the expectation that it would provide useful data to inform the development process.

Despite the difficulties of working with an incomplete version of the software the reaction from students was strongly positive. On a 5 point scale indicating agreement with a series of statements they recorded an average score greater than 4 for statements about the relevance of the software to the work of teachers and about improving their capacity to integrate technology into teaching.

Students reported that they had gained fresh insights into aspects of teaching referenced in the materials they had used. The insights reported were in such areas as physical arrangements of classrooms (13 responses), teachers knowledge of technology (12), teachers self organization (12) and classroom management (10). Several commented favorably on the video clips of interviews with teachers talking about their experience with integrating technology and on the inclusion in the software of a segment which permitted direct manipulation of graphic elements to simulate placement of furnishings in a classroom.

Unfavorable comments were generally restricted to interface issues that were mostly associated with the developmental state of the prototype at the time of testing.

Although limited by the developmental stage of the prototype and the small number of students involved, the preliminary evaluation tends to confirm the general direction of development in this project. Students evidently see value in accessing examples of good practice by teachers and report learning from it. Based on the favorable responses of students to the graphical manipulation of the classroom plan additional exercises using different layouts will be included in the final version and a similar manipulative approach will be used for timetable planning.

Comments from students were also applied to refining the user interface and making the flow of the problem more readily apparent to the user. Based on the comments of students, changes were made to provide more explicit directions at points where responses were required and to permit easier access to the variety of resources available on the CD-ROM.

Conclusion

The folk wisdom of teacher education asserts that teachers teach as they were taught. Clearly this cannot be absolutely and universally true else there would be no development in teaching approaches over time. However, there is sufficient truth in the statement to impose an obligation on teacher educators to ensure that their approaches to teaching, including the use of technology, provide examples of practices worthy of emulation.

Synergistic combinations of effective approaches to teaching with new media have the potential to enhance the learning opportunities for teacher education students both directly through their combined power and indirectly as examples of good practice. Results from the preliminary evaluation of this interactive multimedia CD-ROM based on problem based learning

principles indicate that this may be one of the combinations which will contribute to the next wave of improvement in the preparation of future teachers for teaching with technology.

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